Development of a setup for the study of ball roll behaviour in soccer on artificial turf

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DESSO DLW SPORTS SYSTEMS

Overview

- introduction
- goal
- experimental setup
- results & discussion
- conclusion

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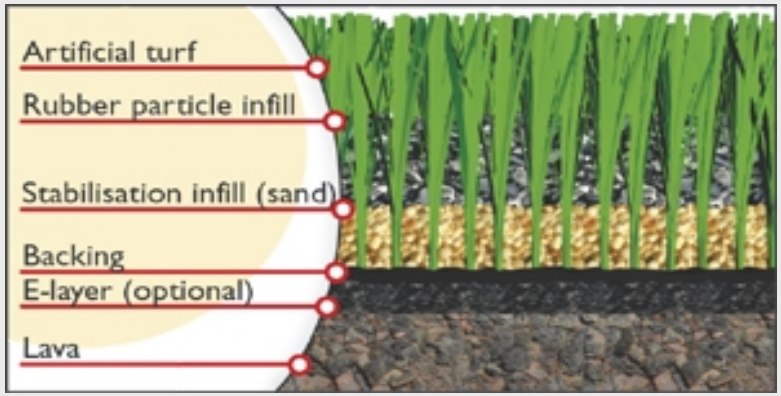
Introduction

- 3rd generation artificial turf: increased use in football, especially for training



- players & clubs still have some resistance for official games on artificial turf
- Joosten(2003): 77% players experience ball speed and roll capacity as high

Introduction

- ball roll distance test (FIFA, UEFA)
  - ball is released from 1m height
  - ball roll distance is measured

    4m < x < 10m → FIFA*

    4m < x < 8m → FIFA**

  - not all fields meet these requirements
  - influenced by external factors (wind, slope, wet/dry, brushing, …)

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Goal

- get a more profound understanding of the ball roll behaviour on artificial turf
- develop an **experimental setup** that allows the investigation of ball roll behaviour on different types of artificial turf, **before and after use**, as well as the necessary **analysis software**

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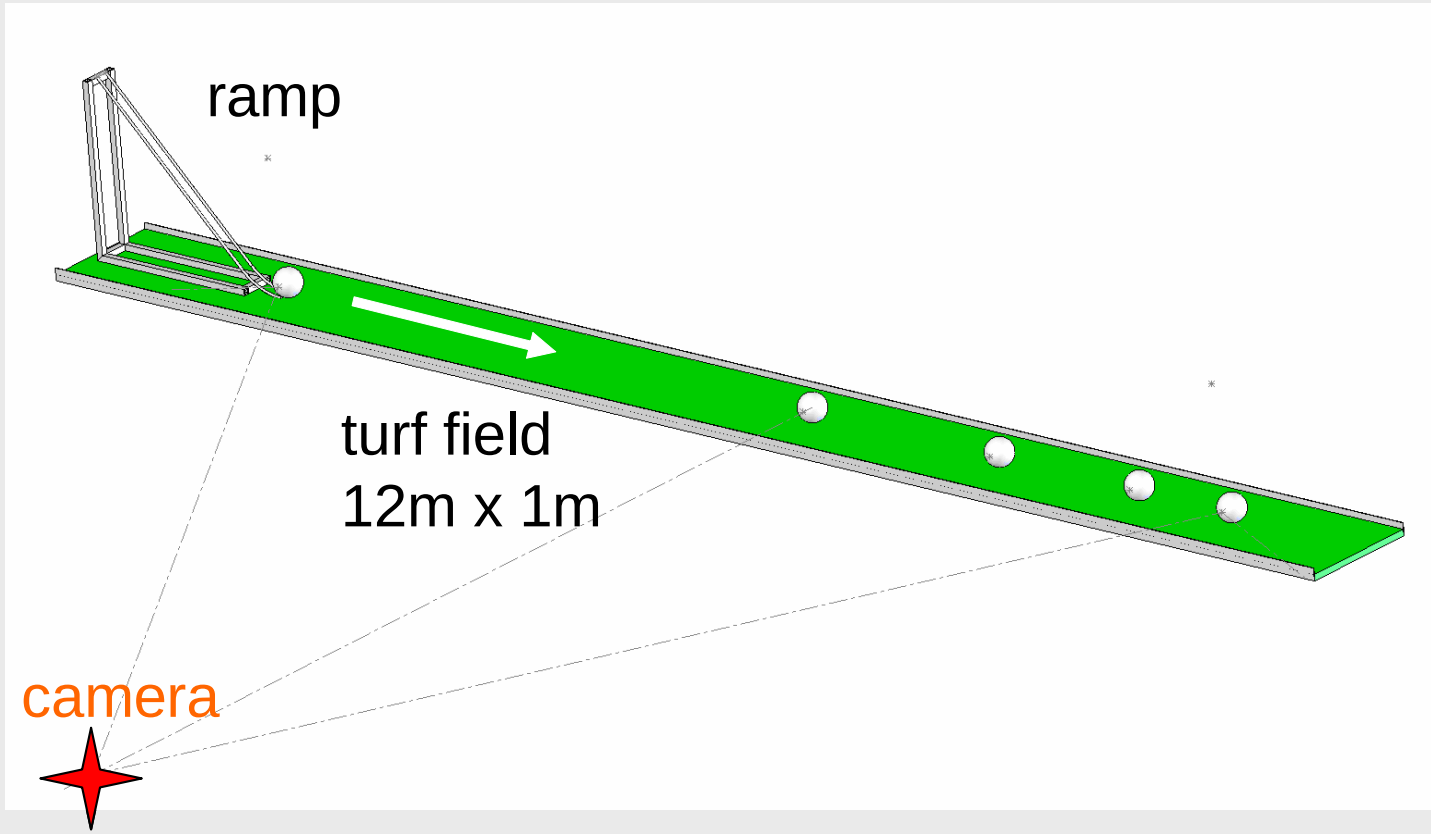
Experimental setup



- Photron Ultima APX-RS (200fps)

Experimental setup: development of image processing software

- software tool: analyse entire ball rolling movement on the turf
- Matlab GUI using the Image Processing Toolbox:
  - automatic ball tracking
  - spin detection
- video = sequence of tiff-images

- each frame:
  - ball position → ball speed
  - ball rotation → spin

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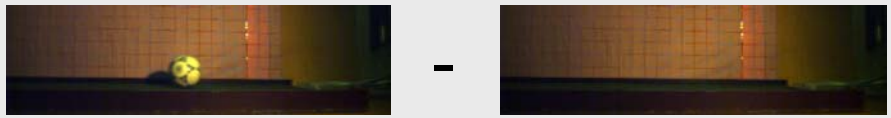
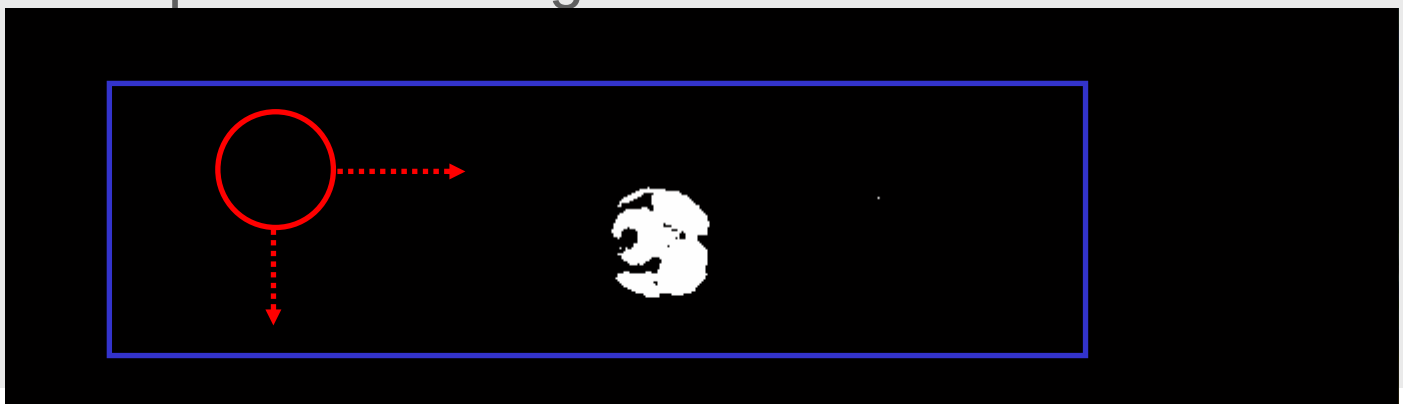
Experimental setup: development of image processing software

- **ball position**
  - background subtraction

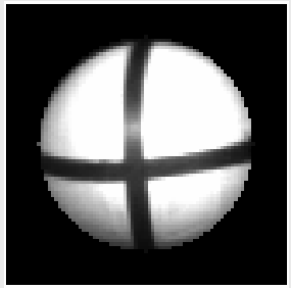


  - conversion to greyscale images
  - conversion to binary images
  - template matching



Experimental setup: development of image processing software

- **ball rotation**
  - cross-hair markers on a white football



  - spin algorithm based on Hull(2002), Goodwill et al. (2006)
  - calculation of rotation between 2 subsequent ball positions
  - rotation → spin

Experimental setup: 12m Lisport

- large-scale version of standard Lisport apparatus
- 12m x 1m samples
- 2 studded rolls
  - 100kg
  - 1m wide
- speed: 0.25m/s
- 40% slip between rolls
- allows to study the effect of **wear & tear** in the laboratory

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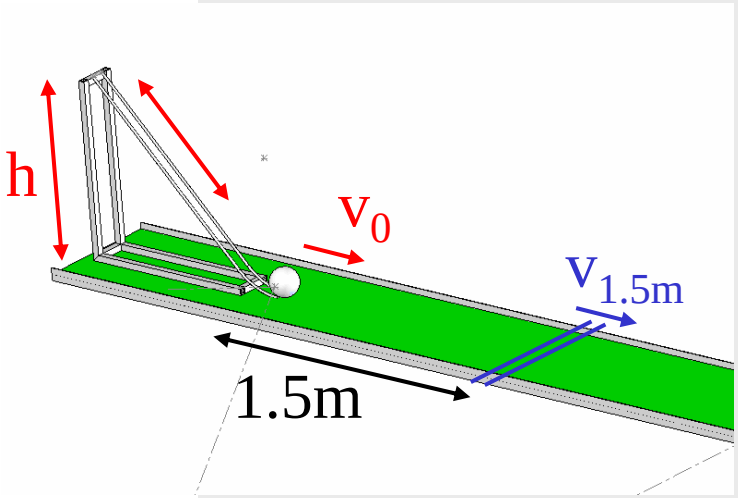
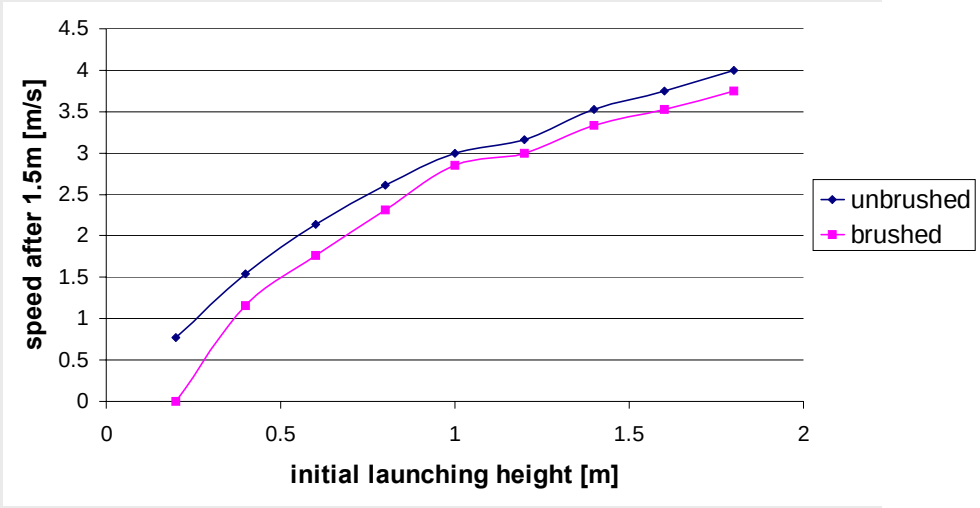
Results: initial tests - brushing

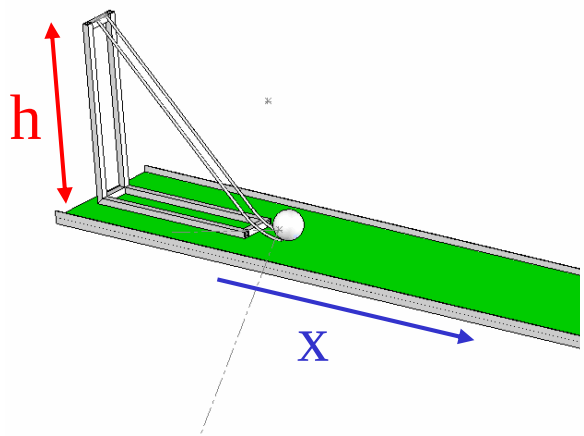
- $v_0 = \sqrt{2gh}$ (no losses or E_{rot})
- influence of brushing: smaller ball speed, especially for small h

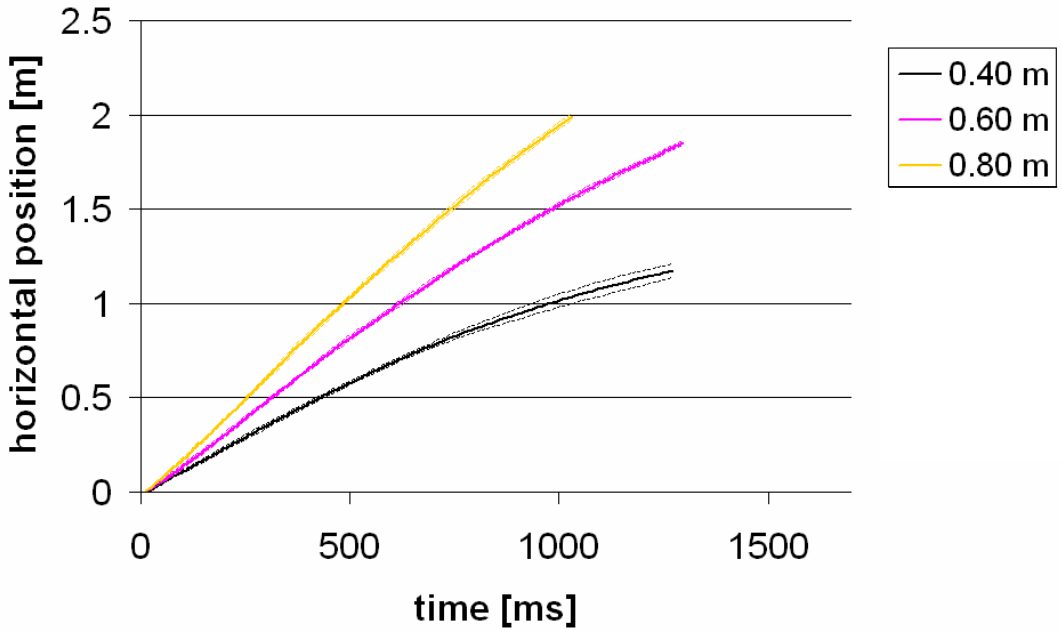




Results: ball roll tracking - position

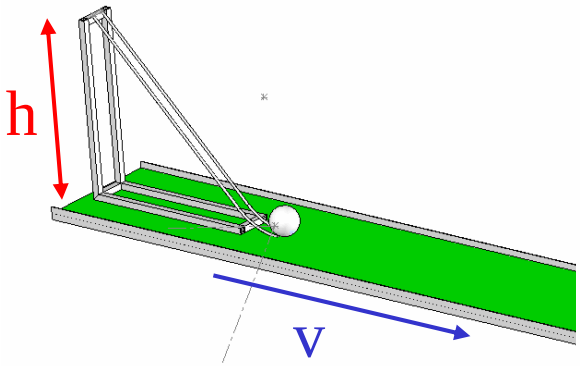
- h=0.40, 0.60, 0.80m (n=3)
- variation is low (max 3%) → tracking is accurate and repeatable

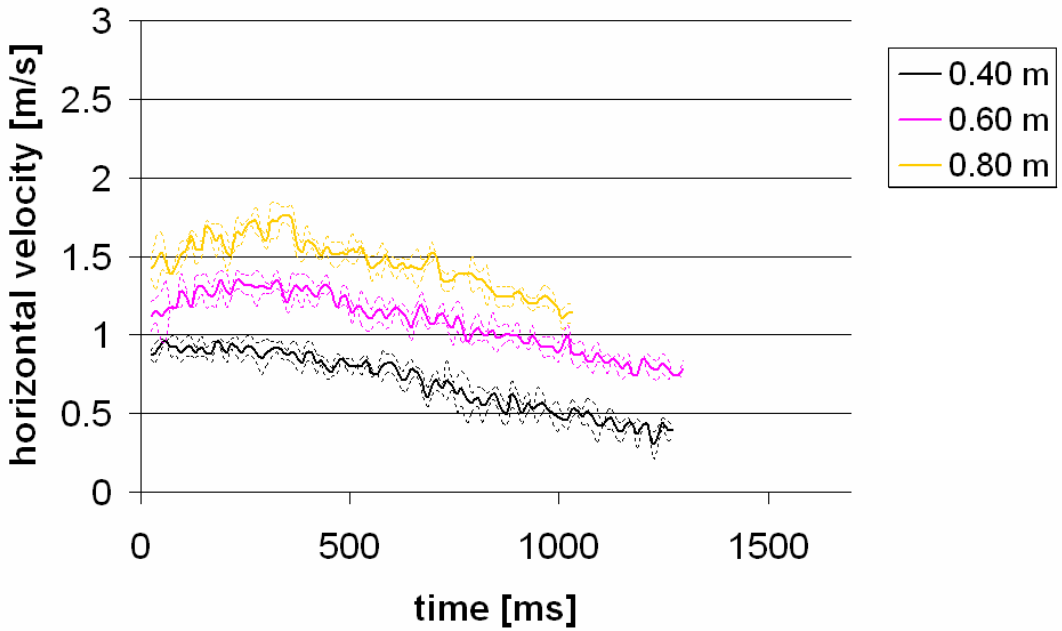




Results: ball roll tracking - velocity

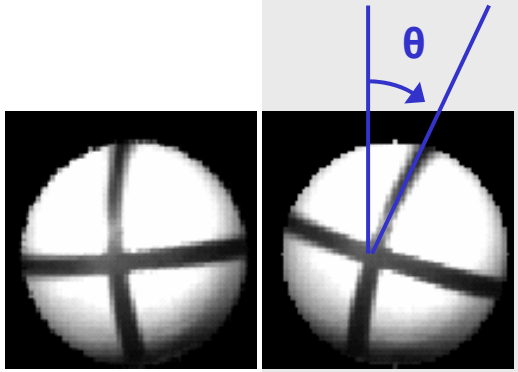
- horizontal velocity increases with h
- initial acceleration: transformation from $E_{kin,rot}$ into $E_{kin,transl}$

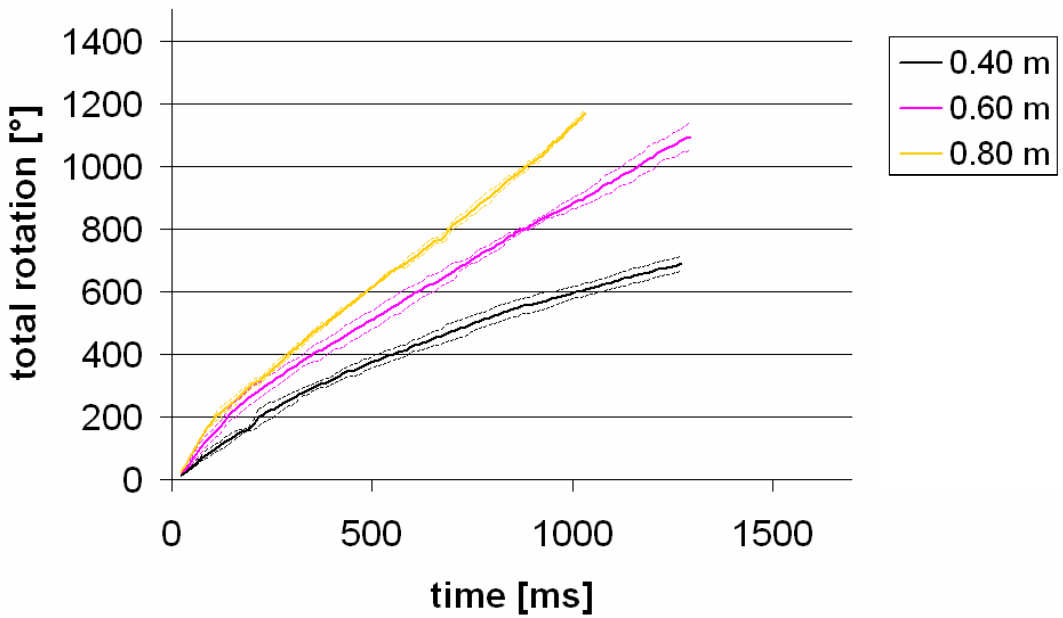




Results: ball roll tracking - rotation

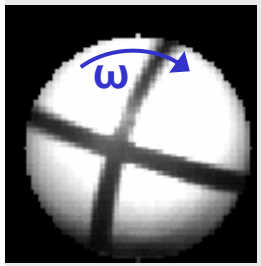
- variation is low (max 3%) → tracking is accurate and repeatable

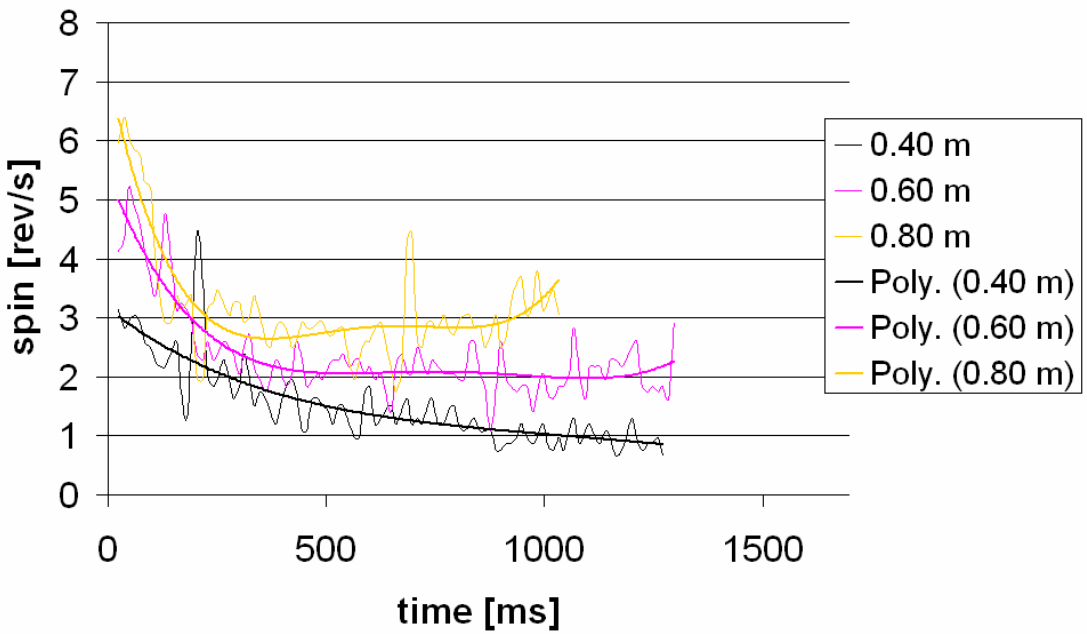




Results: ball roll tracking - spin

- variation is higher
- initial drop in spin: transformation from $E_{kin,rot}$ into $E_{kin,transl}$





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Conclusion

- experimental setup
  - ball roll ramp
  - replaceable artificial mats
  - 12m Lisport
  - high speed camera
- image processing software
  - ball position → ball speed
  - ball rotation → ball spin

Conclusion

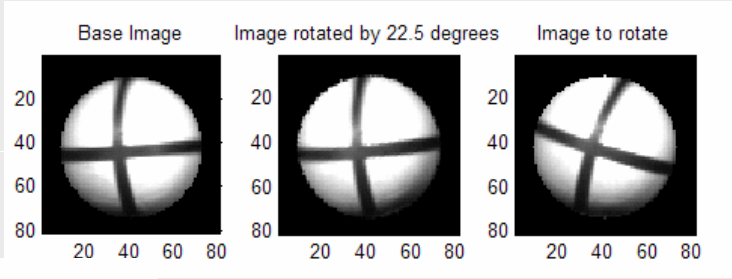
- brushing reduces ball speed, especially at low speeds
- tracking algorithm for ball position and rotation is accurate & repeatable
- ball speed and spin derived
- initial acceleration due to transition effects from ramp to field

Future work

- extra lenses → analysis of ball roll over more than 2 metres
- compare different types of artificial turf
- analyse influence wear & tear with 12m Lisport
- validate mathematical models for ball roll behaviour

backup

-


Base Image
Image rotated by 22.5 degrees
Image to rotate

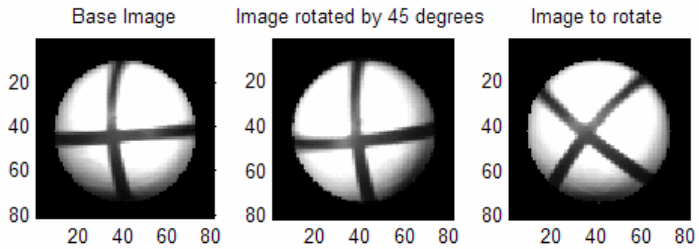

Base Image
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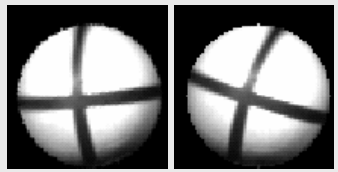
Image to rotate



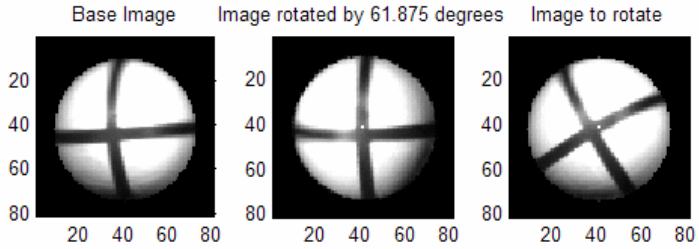

Base Image
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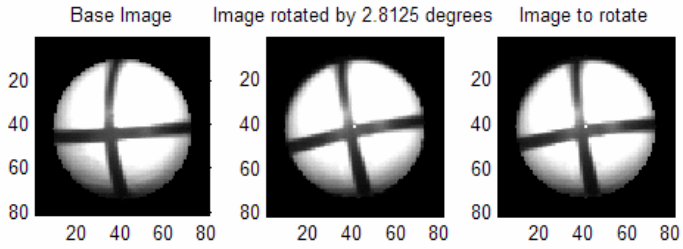
Image to rotate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